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Roadmap for Achieving Additional 2.5-3 Billion Tonnes CO_2e Sequestration from Forestry Sector by 2030

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Summary

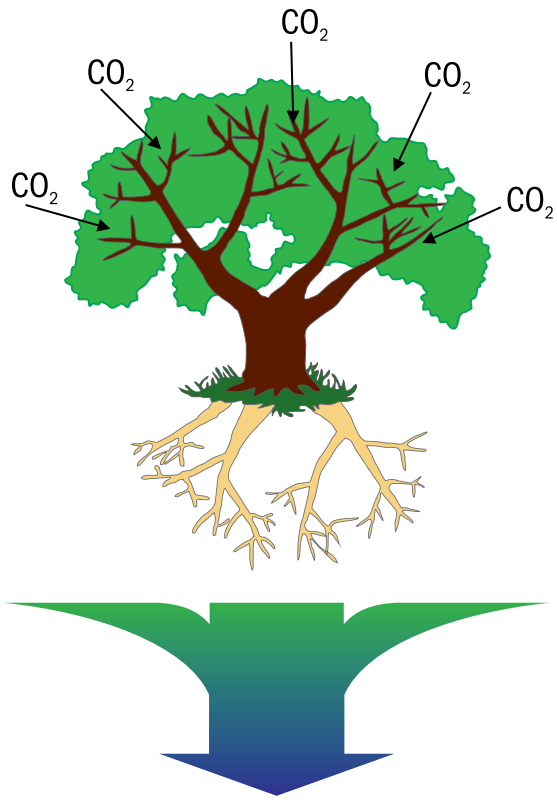
In India, forests are considered as social and environmental resource primarily and more than 275 million people are deriving their full or partial livelihood and sustenance needs. India has stabilized its forest and tree cover but quality of forests is degrading due to unsustainable harvest of fuelwood and other minor forest produce. The Government of India has communicated to UNFCCC to achieve voluntarily additional 2.5–3 billion tonnes of CO_2e by 2030 from forestry sector on October 2, 2015 and further ratified on October 2, 2016. India's mandate of high economic growth, Make in India, house for all, electricity for all, and 1.5 billion population by 2030 will also impact the quality of forests. India has potential to sequester 3 billion tonnes of CO_2e adopting conservation approach with conversion of open forests into moderately dense forests and afforestation of additional 5 million ha. This effort will require ₹100,000 cr per annum till 2030 along with institutional and policy reforms such as capacity building of frontline staff and forest-dependent community, involvement of private entrepreneur for improving the quality of forests, filling the vacancies of frontline staff, community-based forest governance, investment on research and development, creation of National Market for Carbon trading, and carbon neutrality for Corporate/Industry Sector.

Background and Context

Forests in India are treated primarily as social and environmental resource, only secondarily as commercial resource, and committed for implementing sustainable forest management practices (MoEF&CC 2009). National Forest Policy, 1988 embodies all elements of sustainable forest management four years before Earth summit where global community has agreed Forest Principles to implement sustainable forest management (UNCED 1992; TERI 2012). The prime objective of National Forest Policy is to maintain ecological security of the nation along with livelihood and subsistence rights of the forest dependent community including tribals' first charge on forests (TERI 2012). There is strong legal and institutional framework available to implement the policy. The legal tools available for implementing policy into action are Indian forest Act 1927; Forest Conservation Act 1980,Wildlife Protection Act 1972; Forest Rights Act 2006; Environment Protection Act 1986; Biological Diversity Act 2002; and state specific forest laws and rules formulated to implement Central and state laws (Bhargav 2007). Forest is in the concurrent list of the Indian Constitution. The responsibility of central government is policy and planning while implementation responsibility lies with state government. The Forest Rights Act, 2006 provides tenurial security to live cultivates and forest governance (MoTA 2010; Sharma 2009; Samarthan 2012; Jain *et al*. 2015; AITPN 2006; MoEF&CC 2006; MoEF&CC 2007). In this context, government of India has taken decision to go for Gram Sabha-based forest governance. The community-based forest governance is already in northeastern states since ages. More than 275 million people are deriving their full or partial livelihood and sustenance needs from forests, largely on unsustainable basis. Forest cover of the country is 70.17 million ha which is 21.34% of the geographical area (FSI 2015). The areas under very dense cover, moderately dense cover and open forests are 8.59 million ha (2.61%), 31.53 million ha (9.59%), and 30.04 million ha (9.14%), respectively. Natural forests are contributing about 95% to the forest cover of the country. The tree cover of the country is 9.26 million ha which is 2.82% of the geographical area of the country. Total forest and tree cover in the country is 24.16% of the geographical area of the country. The growing stock of India's forests is 4,195.05 million cum and growing stock of TOF is 1,573.34 million cum (FSI 2015). There is increase of open forests but reduction of 0.33 million ha of moderately dense forests, which indicates the forest degradation. Major driver for forest degradation is unsustainable harvest of fuelwood and minor forest produce. Forests are home to 80% of country's biodiversity (FAO 2010), provides 40% of energy needs, 30% of fodder supply, and 50% of grazing requirement along with other NTFPs. The sector provides livelihood support to one-fourth of population living in 173,000 forest-dependent villages. It contributes in sustainable development and meeting the SDGs. In view of the above, it is evident that the anthropogenic pressure endured by nation's forests is enormous.

Box 1

India has 9.14% open forests and 9.59% moderately dense forests. Target of additional 3 billion tonnes of CO_2e could be achieved by converting open forests into moderately dense forests, and converting moderately dense into dense forests along with encouraging agroforestry. India will also be moving fast towards achieving national goal of 33% forest and tree cover in the country. Poverty alleviation and providing income generating activities to FDCs is key to achieve this target and goal of 33% forest and tree cover in the country.



With rapidly growing population and increasing population the pressure is set to in future. This will seriously affect the quality of forests and their sequestration potential. In this context to develop additional carbon sequestration sink of 2.5–3.0 billion through forestry sector is an exceedingly difficult and ambitious task but possible to achieve that requires immediate strong political and financial commitment along with policy and institutional reforms. A brief analysis of impending challenges in attaining desired INDC goals through forestry, possible recommendations and a roadmap for achieving the INDC objectives are summarized in this document.

Forest Degradation in India

India has successfully addressed the problem of Deforestation. Forest Conservation Act, 1980 had played a key role in keeping balance between conservation and development. But forest degradation remains a key concern for quality of forests in India which impacts GDP of the country to the extent of INR 1747565 million per annum(TERI Report,2017). Between 2003 and 2015 continuous improvement has been reported in India's Forest cover as it increased by 14,906 square kilometres or 2.17%, whereas the Growing stock in Forests (GS) reduced significantly by 586.387 million cubic metres or 12.26% (Table 1).

Table 1: Trends of forest resources as reported in India's State of Forest Reports (IFSR)

Forest resource accounting variable	ISFR 2003	ISFR 2005	ISFR 2009	ISFR 2011	ISFR 2013	ISFR 2015	Net Change between 2003 to 2015	% change between 2003 to 2015
Forest Cover (in square kilometres)	686,767[1]	692,027[2]	690,899	692,027	697,898	701,673	14,906	2.17
Growing Stock in Forests (million cubic metres)	4,781.414	4,602.04	4,498.7	4,498.73	4,173.36	4,195.047	-586.367	-12.26
Growing Stock in Forests and Tree outside forests (million cubic metres)	6,413.752	6,218.28	6,098.2	6,047.15	5,658.05	5,768.387	-645.365	-10.06

Source: FSI 2003; FSI, 2005; FSI 2009; FSI 2011; FSI 2013; FSI 2015

This reduction in growing stock despite increasing forest covers is an indicator of forest degradation (FSI 2011). Within the recorded forest, 94.96% of forest is prone to crop injuries and 39.94% has inadequate regeneration, and 5.05% has no regeneration (FSI 2015). Despite improved forest cover, sharp reduction in GS[3], inadequate regeneration, soil erosion[4], and significant crop injuries underlines deteriorating forest health in India. Forest degradation directly impacts sequestration of GHGs and enhances emissions. Given the context, estimated projections[5] of GHG emissions and removals from Forestry sector (From 2015–2030) are presented as under.

Forest degradation is difficult to detect from spatial data and is critical parameter to monitor impacts on biodiversity and carbon sequestration (FAO 2015). At present, Forestry Sector in India is net source of GHGs as shown in Table 2. Annual average productivity of forests and tree outside forests have been considered

Box 2

There is reduction in the growing stock from 2003–2015 and will be further reduced if policy and programmes implemented business as usual. Forestry sector will be net source of GHG emissions in future due to unsustainable harvest of fuelwood and other MFPs, forest fire, overgrazing and poor regeneration. The overdependence on forests for livelihood has to be substituted with natural resource based livelihood and irrigated agriculture which requires ₹40,000 cr per year along with other interventions such as community-based forest governance, capacity building of frontline staff and community, and involvement of private sector. This effort will help in sequestering around 0.9 billion tonnes of CO_2e by 2030.

1 Forest cover corrected for change of scale reported in IFSR 2009
2 Forest cover corrected for change of scale reported in IFSR 2009
3 GS of Forests reduced by 282.68. Million cubic meters in six years between 2003 and 2011 in past 8 year while it reduced by 325.369 million cubic meters in just two years between 2011 and 2013.
4 87% of forest area in India is estimated to have soil erosion
5 Biomass gain and loss method has been adopted for estimating GHG emissions and removals.

for the estimation of carbon sequestration and consumption of fuelwood, paper & pulp, and forests fire have been considered for the estimation of emissions. Timber has been considered as locked carbon for long period. More than 90% contribution towards emissions is due to use of fuelwood for commercial and cooking purposes.

Table 2: Inventory of GHGs in Forestry Sector in India (BAU)

Estimated Emissions/Removals	2015	2020	2025	2030
Total emissions	482.84	539.16	587.71	626.95
Total removals	398.87	408.11	415.03	422.36
Net Emissions	83.97	131.05	172.68	204.59

Source: (TERI Analysis)

Key Challenges

Forest dependence and unsustainable harvest

A significant population of India is dependent on forest resources for fulfilling their needs. Fuelwood, fodder, and timber are the three key direct services provided by forest to the community. Over 853 million people in India use fuelwood, 199.6 million of those collect fuelwood directly from forests, 38.49% of total livestock in India is directly dependent on forests for grazing, around 275 million people living in and around forests are deriving their full or partial sustenance needs from forests (FSI 2011a).

Globally, India accounts for highest annual wood removal of 434,766 thousand cubic metres, 88.6% which is fuelwood (FAO 2015). Annually, 216.47 million tonnes of fuelwood is consumed in India, of which 27.13% comes directly from natural forests. This rate of consumption is well beyond sustainable limits (FSI 2011a) as 61.17% crops in forest area are prone to girdling and illicit felling for fuelwood and timber collection (FSI 2015).Unsustainable harvest of forest produce and NTFPs degrades the ground and middle flora of the forests. Grazing affects 81% of country's forest area, heavy and excessive grazing and lopping for fodder affect vegetation. Around 6% of forest area is prone to injuries from lopping (FSI 2015).

Efforts have been made for fulfilling the increasing demand of fuelwood and timber from Tree outside forests or farm forestry. The demand for timber required by various industries (construction, real state, production of agricultural equipment's, pulp-wood) is primarily fulfilled from farm forestry in India. Still the intense pressure on natural forests for fuelwood, fodder, timber, and NTFP for fulfilling the domestic and industrial needs is a major cause of forest degradation in India. Unsustainable harvest is major driver for forest degradation in India due to livelihood dependence of people living in and around forests.

Forest fires, invasive species pest and diseases

It has been reported that the 54% of the forests in India are prone to fire and over 90% of forest fire are human induced. Forest fire though a natural phenomenon if not controlled or managed properly can cause significant damage to the biodiversity of forest. Forest survey of India has developed advanced forest fire detection and monitoring systems to control this hazard.

Though the detection has become easier the instances of fire have become more pronounced. State Forest Departments have dealt with many cases effectively in recent years but forest fire remains one of the key drivers of degradation in India. Forests are also prone to attacks by pest and diseases—these are natural phenomenon—what is more concerning is the increasing extent of invasive species, such as *Lantana, Parthenium,* and *Eupatorium.*

These species often come up in degraded forest patches and spread extremely fast. The rapid growth and regeneration of these species suppress growth of indigenous species and affect local biodiversity.

Inadequate human resource and their capacity

Management of forest resources is a difficult task which requires close interaction with local communities and in-depth idea of field. The presence of forest staff, particularly frontline staff on field is necessary for successful protection and management of forests. The Department over the year has been operating well below its sanctioned strength, at present the gap between sanctioned strength and in-field staff is 18%. The gap is more pronounced (20%) for forest guards who are the primary in-charge of on-field operations. The overall sanctioned strength of department is limited in itself but understaffing makes the proper implementation of policy and programmes more difficult.

For the management, administration, protection, and development of the Forest Sector there is an organized and uniform hierarchical structure with well-defined jurisdiction in most states of the country. The sanctioned strength of the field executive staff is more than the posts that got filled. The field executive staff as well as all other supporting staff is also recruited by state/UTs Governments and vacancies. The recruitments by the Central Governments and State Governments to different positions however are not regular. The total number of filled positions and vacancies of the Field Executive staff in the Forest Department in the country are shown below in Table 3.

Table 3: Category-wise sanctioned strength, filled in positions, and vacancy as in March 2010

Category	Sanctioned Strength	In Position in 2010	Vacancy in 2010
Indian Forest Services	3,034	2,650	284
State Forest services	3,337	2,734	603
Field Executive Staff	134,309	109,685	24,624
Forest Rangers	9,881	7,731	2,150
Deputy Rangers	7,118	6,052	1,066
Foresters	32,459	28,206	4,253
Forest Guards	84,451	67,696	17,155

Source: ICFRE Report, 2010

At present, there is scarcity of frontline staff and field executives including Divisional Forest Officers (DFOs), which is adversely impacting the forest development works.

India has mandated for peoples' involvement in the forest conservation and protection with benefit sharing mechanism on the principle of care and share. There are more than 100,000 JFMCs that are managing more than 22 million forests in the country (TERI 2016) with the involvement of more than ten million people. The communities are lacking the capacity particularly in the context of scientific knowledge for management, protection, and conservation of forest resources. Capacity building of community is key factor for the community-based forest governance. Though Forest Right Act, 2006 empowered Gram Sabha for the forest governance but devolution of empowerment is still awaited except in few pockets. The involvement of people is necessary for achieving 3 billion tonnes of CO_2e sequestration target.

Inadequate financial support for forestry sector

The allocation of plan budget to forestry sector at the Central Government level remains around 1% of total outlay since independence and it has become further lower after devolution of tax share to the state governments. The budget for Forestry sector including the expenditure made by the state governments in India is 2.2% of GDP (Chopra *et al*. 2003).

India has innovated new and additional financial resources such as funds under CAMPA and allocation of financial resources on the basis of forest cover through Finance Commission in the recent past. At present, CAMPA have ₹42,000 cr in the corpus which is not sufficient for catering even one year requirement if we plan to achieve additional 3 billion tonnes CO_2e sequestration target by 2030. Poverty alleviation schemes have to be merged with forestry schemes to cater the income generating activities in 173,000 forest fringe villages covering more than 300 million people.

Around 40% of the fund requirement could be met without making additional financial burden on the Government. Rest 60% requirement needed for afforestation could be met with mandatory 20% allocation under MNREGA, IWMP, and other rural development schemes. Another innovative mechanism

for generating financial resources for forestry sector is to create national level market for carbon having policy and regulatory regime for corporates to be carbon neutral.

Climate change history and India's INDC

Climate change basically refers to the rise in average surface temperatures on Earth. Historical emissions since 1880 have resulted in rise in global temperature by 0.85°C (MoEF&CC 2012). As on 2009, the historical carbon space occupied by India is only 3%. The percentage share of India in Global Annual Emissions as on 2012 is 5.7%. India, even though not a part of the problem, has been an active and constructive participant in the search for solutions. At the 19th COP in Warsaw in 2013 all countries were required to prepare INDCs and present them before COP21 in Paris. The Government of India has approved India's INDC saying it is balanced and comprehensive. India has communicated its INDC on October 2, 2015 and it has been ratified on October 2, 2016. Now, it is India's responsibility to achieve its mandate. India has committed to reduce the emission intensity per GDP by 33–35% by 2030, and additional sequestration of 2.5–3 billion tonnes of Co_2e from forestry sector.

Roadmap for achieving additional 3 billion tonnes of CO_2e sequestration

It is important to understand the latest status of forests and tree resource in India before preparing a roadmap to achieve 3 billion tonnes of CO_2e sequestration targets which is as under:

Table 4: Forest and Tree cover of India as per ISFR 2015

Class	Area (km^2)	Per cent of Geographical Area
Forest Cover		
Very Dense Forest (> 70% canopy)	85,904	2.61
Moderately Dense Forest (40–70%)	315,374	9.59
Open Forest (10–40%)	300,395	9.14
Forest Cover		
Tree Cover	92, 572	2.82
Scrub (<10%)	41,362	1.26
Non Forest	2,544,228	77.40
Total Geographical Area	3,287,263	100.00

As mentioned in the above table, we have scope of converting around 30 million ha open forests into moderately dense forests and part of moderately dense forests into dense forests through conservation approach and assisting natural regeneration. We will be able to achieve around one-third of the target with conservation approach. Rest two-thirds target could be met through afforestation on non-forest land. As forest is concurrent subject governed by both state and central government, to achieve 3000 million tonnes of additional sequestration in the next 15 years through forestry sector in India, all states have to contribute. The target is thus being distributed among the states on the basis of Forest cover and total area of productive wastelands[6], equal weightage had been given to forest cover and area of productive wastelands (Table 5).

Box 3

Forests are in the concurrent list of the Constitution of India. The responsibility of policy and planning is with Central Government and implementation of policy and plans are with state Governments. The target of 3 billion tonnes has to be distributed amongst the state/UT Governments on the basis of forest and tree cover as well as available waste land for the afforestation. The financial resources will also be allocated accordingly. There is need to have political commitment to achieve this target at the Central Government and state Government level and country should also think about carbon neutrality and also to create National Level Market for Carbon .

6 Wastelands that may be taken up for afforestation and restoration activities, area of nonproductive wastelands that do not support vegetation such as barren and rocky areas, sand dunes, glaciers etc. is excluded while distributing targets

Table 5: Proposed distribution of INDC target for Indian states and union territories[7]					
State	Target (MT)	% equivalent	State	Target (MT)	% equivalent
Maharashtra	361.81	**12.06**	Manipur	45.85	**1.53**
Rajasthan	338.31	**11.28**	Kerala	45.56	**1.52**
Madhya Pradesh	228.88	**7.63**	Meghalaya	44.32	**1.48**
Karnataka	210.50	**7.02**	Mizoram	41.08	**1.37**
Odisha	206.19	**6.87**	Nagaland	40.98	**1.37**
Gujarat	189.01	**6.30**	Bihar	28.05	**0.94**
Jharkhand	156.62	**5.22**	Tripura	24.13	**0.80**
Chhattisgarh	154.91	**5.16**	A & N Islands	15.03	**0.50**
Arunachal Pradesh	137.16	**4.57**	Haryana	8.25	0.27
Telangana	113.37	**3.78**	Sikkim	8.22	**0.27**
Andhra Pradesh	93.52	**3.12**	Goa	8.15	**0.27**
Jammu & Kashmir	89.51	**2.98**	Punjab	4.52	**0.15**
Tamil Nadu	81.15	**2.70**	Dadra and Nagar Haweli	0.83	**0.03**
Himachal Pradesh	70.72	**2.36**	Delhi	0.59	**0.02**
Assam	69.18	**2.31**	Puducherry	0.11	**0.00**
West Bengal	66.33	**2.21**	Chandigarh	0.09	**0.00**
Uttarakhand	60.97	**2.03**	Daman and Diu	0.08	**0.00**
Uttar Pradesh	55.98	**1.87**	Lakshadweep	0.08	**0.00**
Excluded Nonproductive wasteland					
Barren Water erosion	Barren, salinity	Settlements	Barren Wind erosion	Barren, Water erosion	Barren, Mass movement
Frost shattering, Glacial movements shattering	Sand dune /Water logging	Dune/Water erosion	Sand dunes/Wind erosion	Barren Rocky	Sand dunes/Wind erosion

To achieve India's INDC goals a mix of conservation and afforestation approach is needed. The conservation approach will involve protection and conservation of open forests so they can be converted into moderately dense forests through assisting natural regeneration and gap plantations. Conservation approach involves income generating activities for reducing dependence on forests of forest dependent communities. Twenty five to thirty tonnes of CO_2 will be sequestered by providing livelihood to people who are living in and around the forests and also keeping harvest under sustainable limit. It requires ₹40,000 cr per annum for assisting natural regeneration and providing income generating activities for the forest-dependent communities. The conservation approach will help in carbon sequestration of 0.9 billion tonnes of CO_2e along with poverty alleviation. The afforestation approach on the other hand will involve large scale plantation on non-forest

7 For some All union territories except Delhi, the area of wastelands are not available, therefore only forest cover has been taken into account whose weightage was doubled

land. Around 5,000 million seedlings have to be planted in the next ten years. It requires 5 million ha additional non-forest land for afforestation and expenditure of around ₹60,000 cr per annum. The implementation of above mentioned measures for achieving INDC target requires an average annual investment of over one lakh five thousand and fifty four crore for next fifteen years and additional 5 million ha land for afforestation in India. The state-wise, required financial estimations for next fifteen years were estimated for implementation of mentioned measures (Table 6), a discount rate of 6% was also assumed for making estimations.

Table 6: State-wise financial outlay needed for achieving INDCs through forestry sector till 2030

State	Overall outlay needed (in ₹Crores)	Average Annual Needed (in ₹Crores)	State	Overall outlay needed (in ₹Crores)	Average Annual Needed (in ₹Crores)
Maharashtra	172895.6	11526.38	Nagaland	23404.23	1560.28
Rajasthan	161872.5	10791.50	Manipur	23060.93	1537.40
Madhya Pradesh	127899.9	8526.66	Meghalaya	21637.3	1442.49
Karnataka	105636	7042.40	Mizoram	20226.54	1348.44
Odisha	99539.36	6635.96	Tripura	19682.39	1312.16
Gujarat	92375.69	6158.38	Bihar	15006.97	1000.46
Chhattisgarh	86266.2	5751.08	Goa	10102.88	673.53
Jharkhand	84527.04	5635.14	Punjab	9576.50	638.43
Arunachal Pradesh	66750.4	4450.03	Haryana	9102.34	606.82
Telangana	57794.24	3852.95	Sikkim	7902.03	526.80
Andhra Pradesh	47673.49	3178.23	A & N Islands	7170.50	478.03
Jammu & Kashmir	45914.75	3060.98	Delhi	595.11	39.67
Himachal Pradesh	44474.63	2964.98	Dadra and Nagar Haweli	393.79	26.25
Kerala	40857.86	2723.86	Puducherry	51.73	3.45
Tamil Nadu	39831.43	2655.43	Chandigarh	42.11	2.81
Assam	38443.44	2562.90	Daman and Diu	37.49	2.50
Uttarakhand	34996.57	2333.10	Lakshadweep	37.49	2.50
Uttar Pradesh	33949.28	2263.29			
West Bengal	31640.65	2109.38			

Way forward

Allocation of financial resources is not sufficient to achieve these targets. There is need to implement following suggestions for achieving these targets.

- The very dense forest area should be conserved, Efforts should be taken for improvement of moderately dense forest to very dense forests while the degraded and open forests areas into moderately dense forests through conservation, restoration and afforestation. While doing so, encroachment of important ecosystems, such as wetlands and grasslands for developmental purposes should be discouraged. Such ecosystems must also not be converted into plantations for the sake of increasing forest cover.
- Livelihood of forest-dependent communities should be taken on priority to avoid unsustainable harvest of forest produce. Conservation plans must go with poverty alleviation programmes, particularly on forest fringe villages.
- Substantial financial allocations to the forestry sector is needed for:
  - Implementation of poverty alleviation schemes in forest fringe villages

  - For afforestation, reforestation, protection, and management
  - Research and development of quality planting material
- Filling of the vacancies of frontline staff in the Forest Department has to be done.
- Livelihood of forest-dependent communities should be taken on priority by Forest Department to avoid unsustainable harvest of forest produce. Forest conservation should be linked with poverty alleviation schemes.
- Forest Governance to be synchronized with Gram Sabha based forest governance limiting forest department to technical guidance, monitoring and implementation of forest related legislations.
- Policy intervention to permit private sector for plantation and restocking of degraded forests.
- There is a need to produce high yielding varieties for promoting the Agro Forestry Production.
- The harvest of forest produce, particularly fuelwood and fodder is considered to be limited under sustainable limit to avoid forest degradation and to promote better regeneration.
- The carbon assessment and socioeconomic survey has to be a compulsory exercise while preparing the working plan.
- Industry has to be encouraged to plant more and high yielding varieties to produce more wood and sequester more carbon.

Conclusion

- India has potential of achieving additional 3 billion tonnes of CO_2e sequestration by 2030 with conservation and afforestation approach on forests and non-forest land. More than one lac cr per annum is needed till 2030 and later, which could be available from the existing poverty alleviation and rural development schemes. This effort will provide empowerment of community, poverty alleviation, clean environment and forest, wildlife and biodiversity conservation. It is not possible to achieve this target without involvement of people, private sector, and other government departments. Additional 5 million ha land may be difficult but same target could be achieved in lesser area with high yielding and quality planting material. The most important is to have political commitment to achieve this target which is lacking in the country. In the recent past, the respective chief ministers of UP, Maharashtra, and Andhra Pradesh have shown commitment towards having special drive for afforestation. The same kind of political commitment should be from Central Government and other state governments are needed on regular basis.

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